Looking for Radium in All the Right Places

Minnesota Ground Water Association

Fall Conference

November 17, 2005

St. Paul, Minnesota

Radium occurs in Minnesota Ground Water

- Radium present in ground water nearly everywhere; highest in Paleozoic rocks
- Radium present in other areas of North America:
  - Other North Central states
  - East coast states

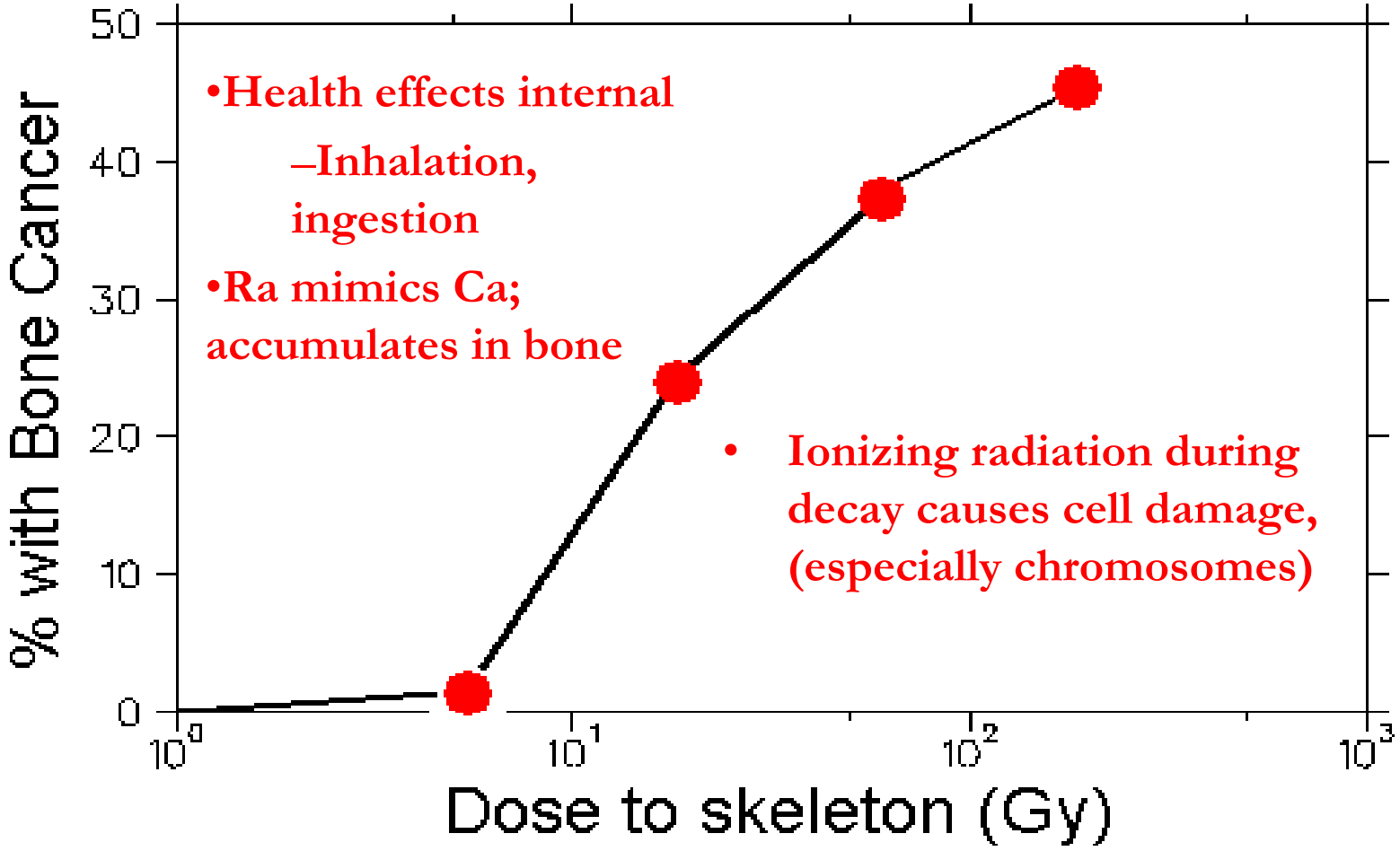
EPA Radionuclide Rule Revised 2003

- Community water systems must:
  - Meet MCLs
  - Monitor
  - Report

- Revised MCLs:
  - Total radium: 5 pCi/L
  - Gross alpha: 15 pCi/L
  - Uranium: 30 ug/L

One picocurie per liter (pCi/L) equals 2.2 radioactive disintegrations per minute per liter of water

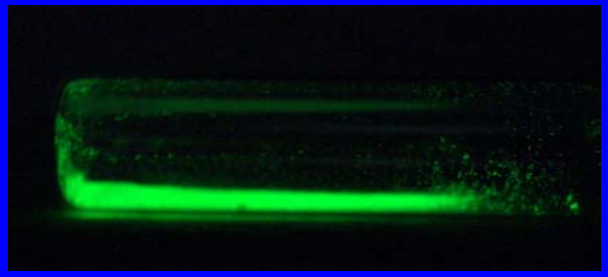
Health Effects of Radium



http://www.mun.ca/biology/scarr/Radium_Watch-Dial_Painters.html

Characteristics of Radium

- Naturally-occurring, radioactive metal
- Three major isotopes: Ra228, Ra226, Ra224
- Ra226 most persistent isotope (1600 year half-life), and most common
- Ra226 occurs through U238 decay by alpha particle ejection



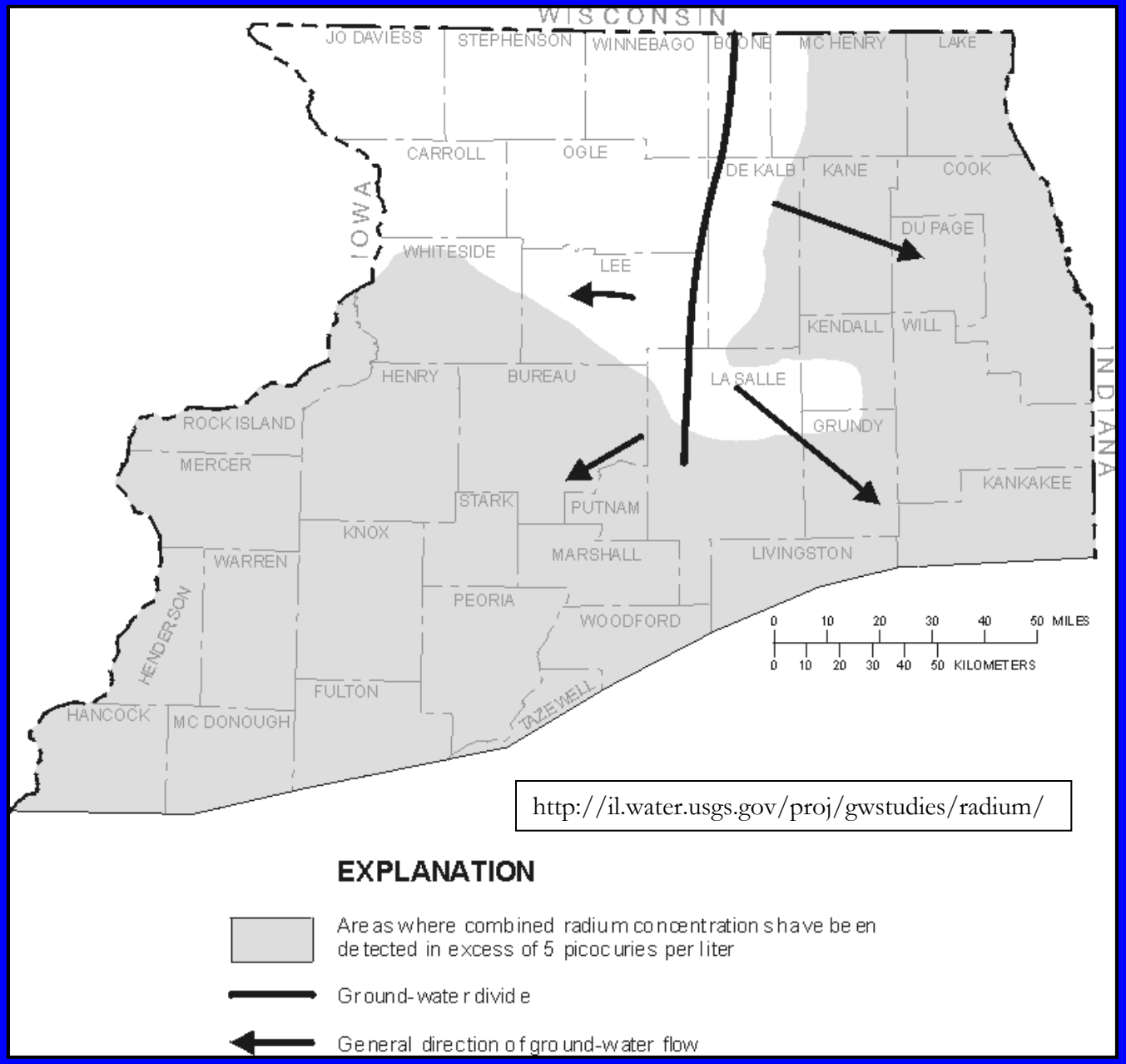
http://www.lispme.de/pse/88_Ra_en.html

Radium Behavior in Ground Water

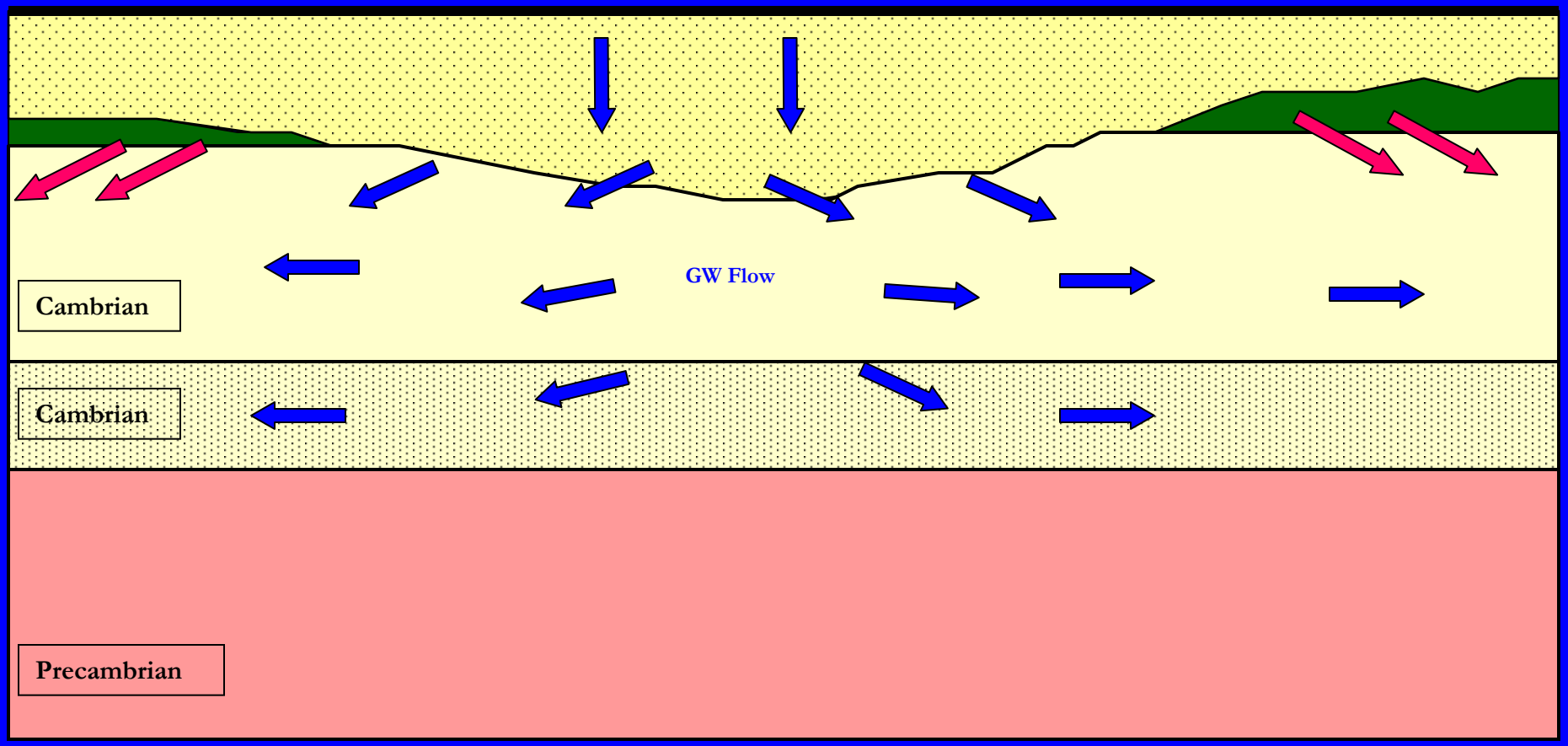
- Low solubility in water, under reducing conditions
- Enters ground water by:
  - Dissolution of aquifer materials
  - Desorption from rock or sediment
  - Ejection by radioactive decay

High radium concentrations in the Ironton-Galesville aquifer of Northern Illinois are:

- Far from overlying shale
- Far from recharge at ground water divide



USGS Model for Northern Illinois



Radium in Mt. Simon Aquifer (CMTS) in Minnesota

MGS study, 1992

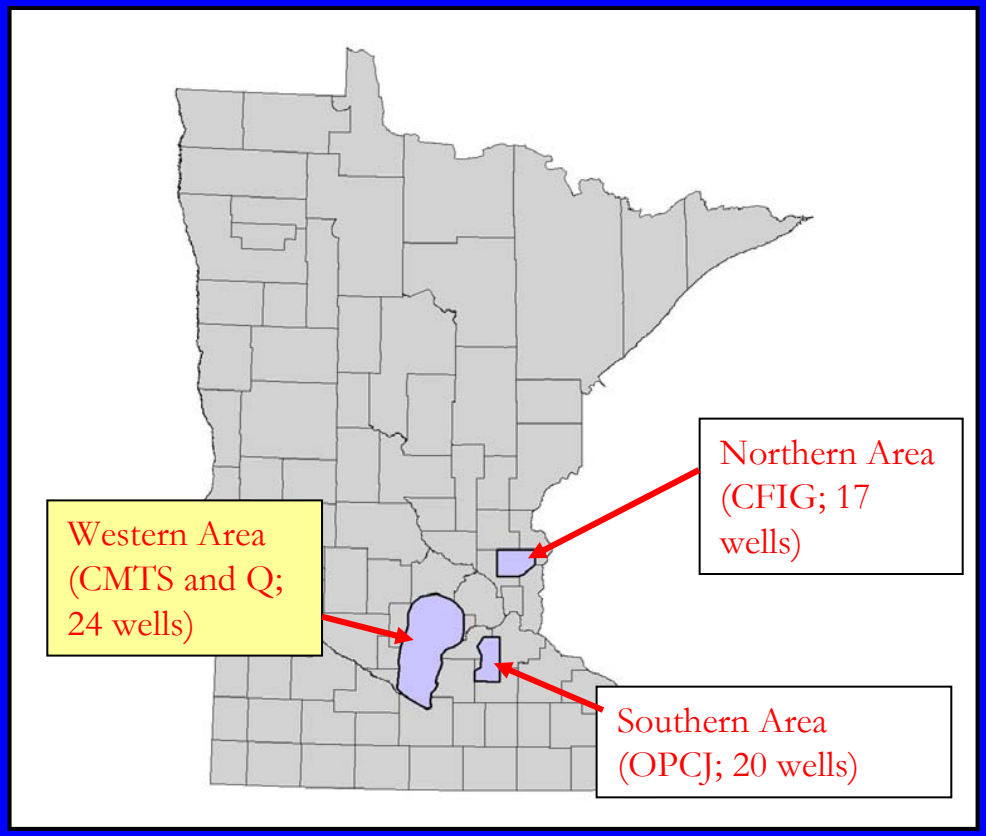
- Most CMTS wells exceed MCLs
- No consistent spatial patterns
- Hypothesize high radium is related to proximity to faults, high chloride and sulfate concentrations, and greater age

MDH Radium Study Goals

- Build on earlier studies
- In 3 areas of Minnesota, help newly-drilled wells avoid radium above the MCLs, reduce human exposure
  - Northern metro area (CFIG)
  - Southern metro area (OPCJ)
  - Western area (CMTS)
- Improve understanding of the occurrence and distribution of radium in Minnesota's drinking water aquifers

MDH Radium Study

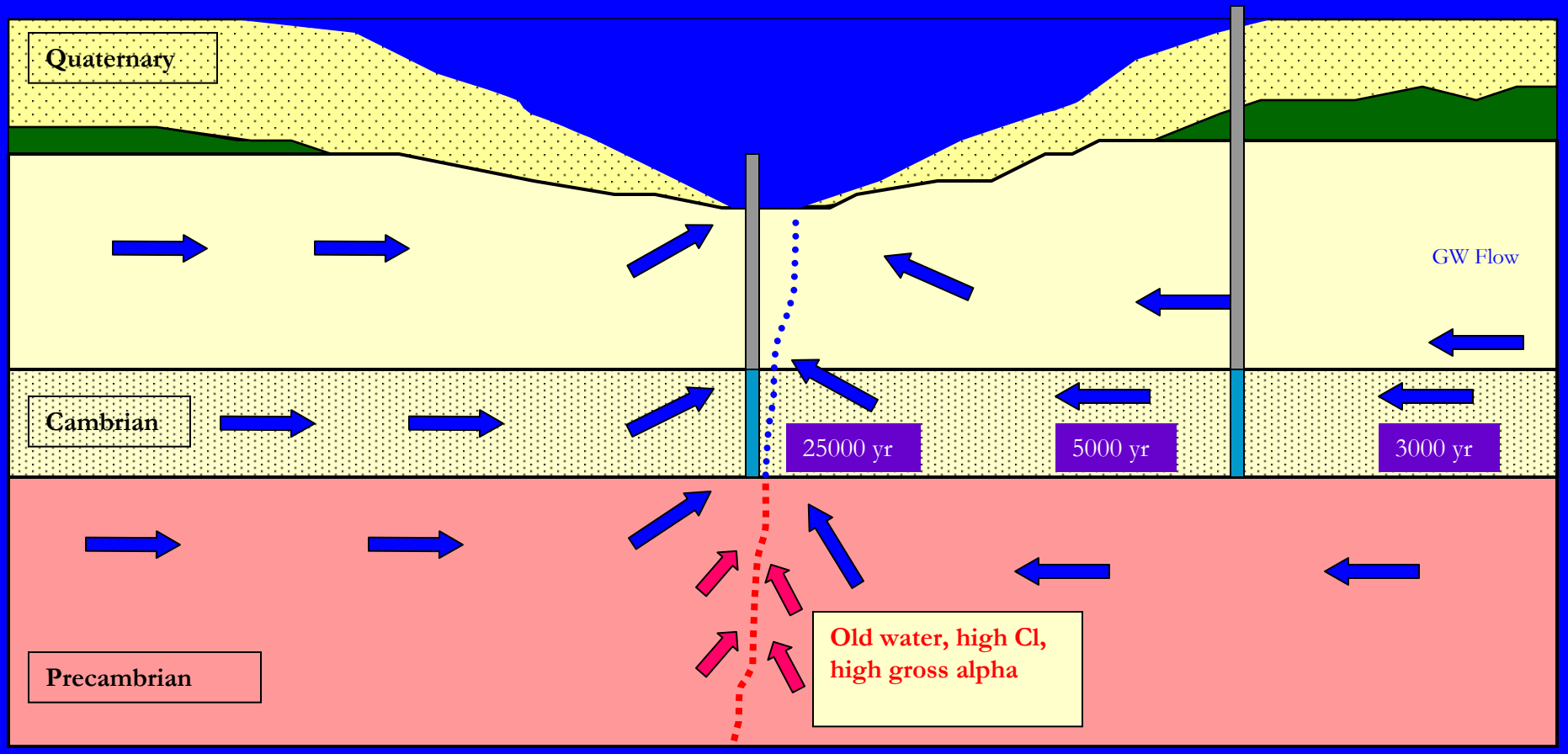
- Currently underway
- Measure
  - Ra 226, Ra 228, Gross Alpha, Uranium
  - Arsenic, Iron, Manganese
  - Major ions
  - Field measurements



Plus additional data from MNDWIS

Working Hypothesis (from MGS, 1993)

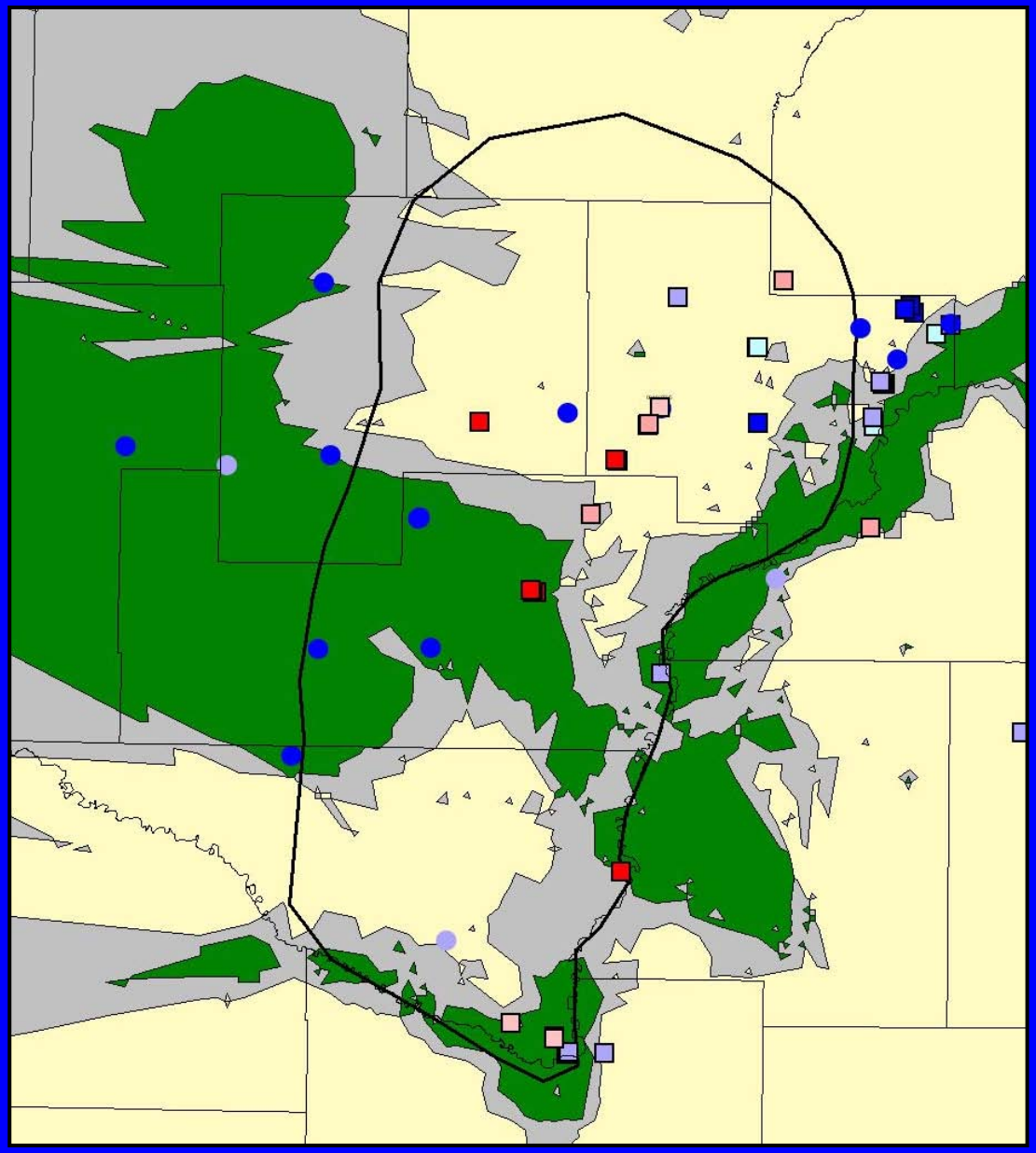
- Radium/gross alpha concentration is related to age of water
- Age of water is related to discharge zones
- Discharge zones related to basement structure
- Radium/gross alpha distribution in CMTS might be related to basement structure.



Early Results

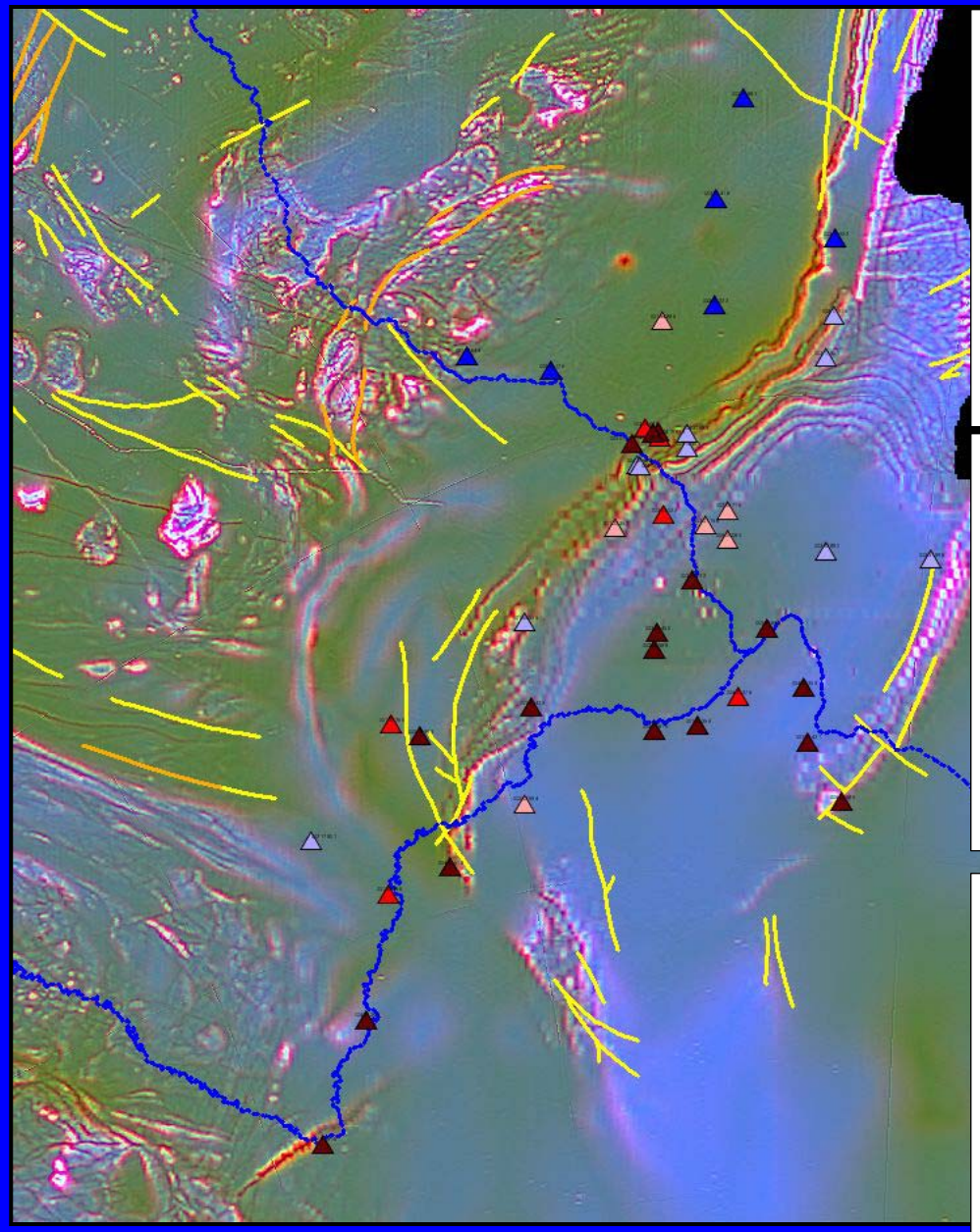
- Poor correlations
  - Gross Alpha vs. well depth
  - Major ions vs. Ra228/Ra226
  - Ra 226 vs. [SO_4], [Mg], [Ca], and [Mn]
  - Gross Alpha vs. pH
  - Chloride vs. Age
- **R^2 ranges from 0.0040-0.20**

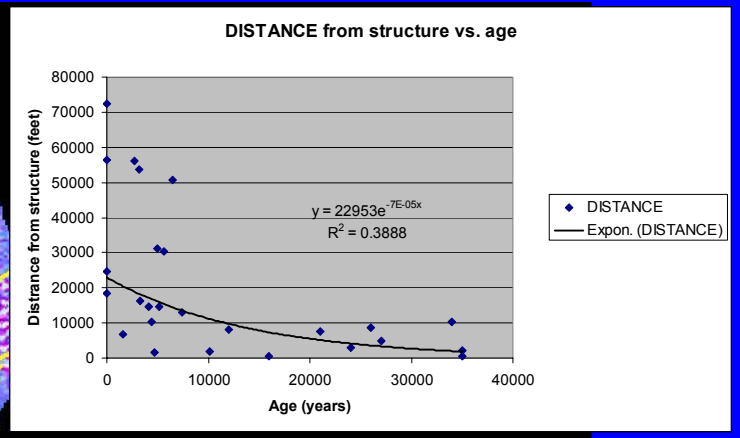
- Stronger correlations
  - Ra228 vs. Ra226
  - Total Ra vs. GA
  - GA vs. SC
  - Ra226 vs. Cl
  - Ra226 vs. Na and K
  - Ra226 vs. HCO3
- **R^2 ranges from 0.23-0.67**

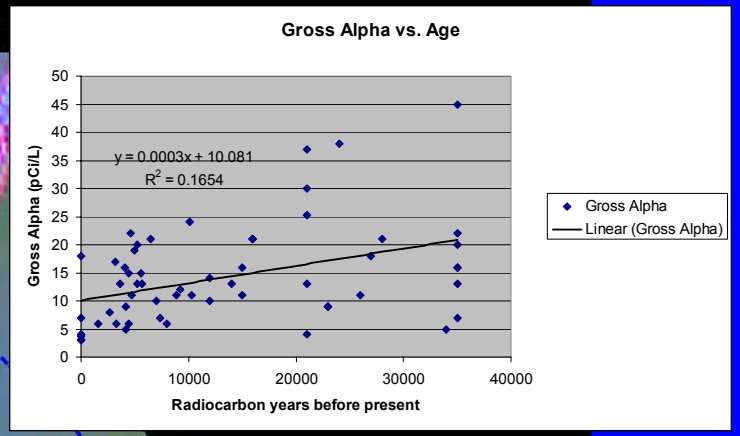


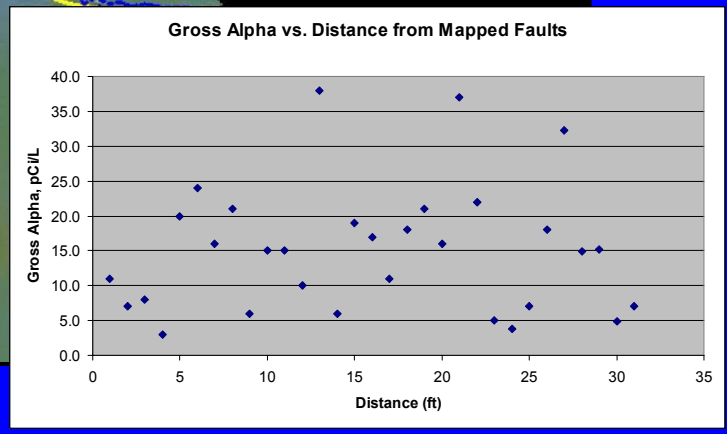
Gross alpha in the CMTS and direction of vertical gradient

Radiometric age, Aeromagnetic data, Structural geology









DNR coverage, MGS data

Summary

- Most measured parameters were poorly correlated to radium occurrence
- Best correlations involved SC, chloride, bicarbonate, sodium, potassium, and GA as indicator of total radium
- Quaternary deposits of the DML do not appear to be a source of radium
- Some data are consistent with radium occurrence in CMTS due to recharge from below, however not straightforward.

Further anticipated work

- Continued sampling
- Filtered vs. unfiltered samples, selected wells
- Time series sampling during purge
- Time series sampling over longer time frame (newly drilled wells)
- Gamma kick at SWL
- Flow logging (MGS)